The Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,
Director of Carleton College Observatory.

JANUARY, 1886.

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By faith we understand that the worlds have been framed by the word of God, so that which is seen ha'h not been made out of things which do appear.

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XUM

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 5. No. 1. JANUARY, 1886. WHOLE No. 41.

SMALL TELESCOPES VS. LARGE.

PROFESSOR C. A. YOUNG.

[For the Messenger.]

Although the subject has been pretty thoroughly canvassed of late, it may, perhaps, be permitted to add a few words more to the discussion.

The first thing to be said, and always borne in mind, is that the excellence of an observer's eye and his power of *perceiving* what he sees (i. e. of getting an idea from the impression on his retina) have quite as much to do with the discovery and delineation of planetary features as the excellence and power of the telescope used. The writer certainly would not expect to be able to make out with the instruments of such eagle-eyed observers as DAWES and KAISER and SCHIAPARELLI all that they detected. Mr. DENNING has quoted against the great telescope at Washington the small amount of detail shown upon certain drawings of *Mars* by Professor HARKNESS. But it is well known to many that other drawings, made about the same time, by a junior observer, and since then communicated to TERBY at Louvain, exhibit everything that appears upon the best maps of SCHIAPARELLI. It is altogether probable that an observer blest with exceptionally perfect vision could see on *Jupiter*, with a power of 300 on an 8-inch telescope, all that most of the rest

of us could make out with a power of 800 on an 18-inch instrument:— but give him the larger instrument, and then!—the writer for one is very sure that even the perfect eyes would never again be contented with the smaller glass.

Another remark is that the discordance between the different maps of *Mars* indicates that the best and most keen-eyed of observers unconsciously supplement what they really see, with details which they only *think* they see; so that in the finished drawing fact and fancy are inextricably mingled. The later observer with larger telescope and higher power naturally fails to recognize many features, and some, he has to repudiate.

As regards atmospheric disturbance, there can be little doubt that the smaller beam of light incident upon a smaller object glass is less affected; and so, with a given magnifying power, the image formed by the smaller telescope is somewhat better defined and less veiled by stray light. But the mal-definition produced in this way, instead of increasing with the *cube* of the diameter of the object-glass, as has been asserted, probably varies much more nearly with its square root, or even with some still more slowly growing function. Under ordinary atmospheric conditions, if the writer's experience is worth anything, the patch of stray light around a star image, and its apparent 'dancing' is not nearly twice as great with our 23-inch object glass as with our 9½-inch; using, not the same eye-piece of course, but the same magnifying power in both cases. Usually, in the writer's judgment, this slight gain in definition, only about balances the loss in definition due to the diffraction effect of the diminished aperture. And of course the loss of light is wholly unbalanced.

Probably however the best test would be an actual trial made by varying the aperture of a telescope without changing the magnifying power.

We tried the experiment here on the evening of Friday, the 20th. The night was rather a poor one for star definition: on a scale of *ten* the seeing would be recorded as about five or six. We pointed the telescope on *Saturn*, about $1^h\ 30^m$ sidereal time, using first the whole aperture of 23 inches, and a Steinheil mono-centric eye-piece, giving a power of 480: the object

would not bear a power of 700, which was tried and rejected.

On the outer ring, A, ENCKE's division (?) was faintly perceptible at times, very near the middle of the ring: Y thought it a little nearer the outer edge, but MCNEILL on the contrary, thought it a little inside the middle. No markings were visible on the brighter ring B. The dusky ring C was fairly well seen: it was a little fainter and more transparent on the eastern ansa than on the western, so that the eastern limb of the planet could be traced through it nearly to the edge of ring B. On the planet, the bright equatorial belt was conspicuous, bounded on the southern edge by a narrow dark stripe. Another dark belt was visible near the poles, where the Arctic circle ought to be; and between this and the southern tropic were faintly visible two other narrow darkish stripes, best made out near the planet's central meridian.

On the western side of the planet its shadow was just perceptible on ring C, and on ring B was of course conspicuous. Y. could not perceive certainly anything abnormal in its outline, but McN. thought it *straighter* than it should have been if the ring were plane. It seemed to terminate exactly in the Cassinian division between B and A. *Enceladus* was easily seen, coming out towards eastern elongation, but we could not find *Mimas*.

We now (at 2.0*h*, sidereal time) cut down the aperture to 15 inches. The appearance was only slightly altered. The limb of the planet was perhaps a little sharper, but the inner edge of ring C was not so easily seen. The shadow of the planet seemed to Y. to show indications of a knot or lump where it touched CASSINI's division. ENCKE's stripe was still perceptible. On the whole it was impossible to say whether the smaller aperture, was, or was not, an improvement. *Enceladus* was a little fainter, but still easily seen, and the planet of course was not as bright as before.

About 2:15 or 2:20 we cut down the aperture again; this time to 9 inches: and it certainly made surprisingly little difference — at least that was our impression at the moment. ENCKE's stripe could no longer be made out by Y.; but everything else remained, though ring C was rather misty in outline

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and the eastern limb of the planet not clearly seen through it. The belts on the planet were all visible, and the 'knot' on the shadow, before alluded to, was very evident to Y., though McN. was not so sure about it. *Enceladus* even could still be seen, for the planet was fainter and the background darker. There did not seem to be any gain in sharpness over the 15-inch aperture, and the boiling and dancing was not perceptibly lessened. Still we were obliged to admit that we could see fairly with 9 inches about everything we had been able to make out with the whole aperture.

But now we removed the cap; and this time there was a change. At our first observation the planet was only 25° high, and not fairly out of the haze. Now, at 2:40, it was nearly 40° high, and although the air was still boiling, it had cleared the mists, and shone out splendidly. ENCKE's stripe was perhaps no better seen than at first, but everything else was improved immensely. A faint dark streak came out just on the equator, exactly in the middle of the bright equatorial belt; the tropical belt showed, though not very clearly, a pronounced filamentary structure like that of the belts of *Jupiter*, and the polar cap, inside the Arctic circle belt, showed faintly its peculiar greenish hue. It is to be noted by the way, however, that there was almost none of the bright pink color upon the planet's disc, which was so conspicuous two or three years ago.

On the *east* side of the planet the shadow was now visible as an exceedingly fine dark line, just dividing the planet's limb from ring B, and sharply defining it. On the *western* side the shadow was well seen on ring C, and its outline on ring B was perfectly normal and regular: the imagined knot had disappeared — a mere optical illusion, in this case at least. On ring B a faint, ill-defined, concentric structure was indicated, a sort of 'brush-marking', as if the ring were a painting made with a flat brush, not by radial strokes, but by a circular sweep. There were no distinct stripes that the eye could seize upon, and yet the general impression was quite decided. *Enceladus* shone out strong and clear like a star of 3rd or 4th magnitude; and in spite of the boiling and dancing, and without any previous knowledge of its position, we now detected *Mimas*, creeping

out to conjunction with the western extremity of the ring. Both observers agreed that there was simply no comparison between the 9-inch and the 23-inch aperture. If the 'seeing' had been better, what we should rank as 8 or 9, instead of 5 or 6, the difference would probably have been still more striking.

PRINCETON, N. J., November 27th, 1885.

P. S. We estimated the conjunction (inferior) of *Mimas* with the western edge of the ring as occurring at $2^h\ 51^m$ Princeton sidereal time.

GALLE'S CATALOGUE OF COMETS FROM 1860 TO 1884.

(*Continued from page 273, vol. 4.*)

237. M. N. 26: 84. Observed in the southern hemisphere only. Seen with the naked eye January 17, by ABBOTT at Hobart Town; January 18, by MOESTA at Santiago and by ELLERY at Melbourne; observed at the Cape from January 22 to May 2 by MANN. The above corrected elements by TEBBUTT Jr. represent very well the Melbourne and Windsor observations.

(96) E. Mem. de l'acad. de St. Petersb. 26 (1878). Seen February 13 at Leipzig by BRUHNS and ENGELMANN, and probably, also, before that date, by D'ARREST at Copenhagen (January 25). It could not be observed, however, till after perihelion, when it was seen, June 24, by TEBBUTT at Windsor and MANN at the Cape: last observed at the Cape July 22, though seen again July 23.

238. A. N. 68: 249. Discovered 1865, December 19, by TEMPEL at Marseilles, and 1866, January 5, by TUTTLE at Cambridge, U. S.; last observed February 9 by v. OPPOLZER at Vienna. According to OPPOLZER'S most probable orbit, deduced from all the observations, the period of revolution is 33.18 years. A computation made at the same time by PECHULE (A. N. 68: 270) leads to very nearly the same result. An agreement between the orbit of Comet 1866 I and the orbit of the meteors of November 13, as computed by SCHIAPARELLI and LE VERRIER was remarked by PETERS, and this comet in connection with Comet 1862 III furnished the data for SCHIAPARELLI'S discovery of 1866.

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(163) F. Verhandl. d. Akad. in Stockholm 1872. FAYE'S comet. Found 1865 August 22 at Copenhagen by THIELE; last observed 1866 January 12 at the same place by D'ARREST.

239. A. N. 69:111. Discovered at Marseilles by STEPHAN, January 25, and at the same place by TEMPEL January 28; last observed by WINLOCK, at Cambridge, U. S., April 3. The ellipse satisfies the observations as far as they go.

240 T_1. A. N. 74: 103. Discovered April 3 at Marseilles by TEMPEL; last observed August 21 by SCHMIDT at Athens, though seen till August 27. The elliptic form of the orbit was soon remarked, and it has been confirmed by the return of the comet in 1873 and 1879.

241. A. N. 73: 57. Discovered September 26 by BAEKER at Nauen and about four hours later by WINNECKE at Toennisstein near Brohl on the Rhine. Last observed October 31 at Helsingfors by KRUEGER. Elements from October 1, 14 and 27—in part normal places.

(171) Br. A. N. 93: 183. BRORSEN'S comet. Found at Athens, April 11, by SCHMIDT, and about the same time by other astronomers also; last observed June 23 by SCHMIDT.

242. Manuscript; also Annuaire 1884: 214. Discovered June 13 by WINNECKE at Carlsruhe; last observed July 17 by SCHMIDT at Athens. The most probable parabola from the observations used, divided into seven normals; no ellipticity perceived.

(96) E. Mem. de St. Petersb. 26 (1878). Found July 17 by WINNECKE at Carlsruhe; last observed September 3 by VOGEL at Leipzig.

(131) W. A. N. 97: 338. WINNECKE'S comet. Found by WINNECKE himself, April 9, at Carlsruhe; last observed October 12 by WEISS at Vienna. The first return of this periodic comet since its second discovery, 1858.

243. A. N. 81: 143. Discovered by TEMPEL at Marseilles, October 11; last observed November 12 by WEISS at Vienna. KOWALCZYK, SEYDLER (Wien Ak. S. B. 1871) and DOBERCK (A. N. 79: 384) have made accurate computations of the orbit from the few observations which were obtained. All three computations, although by different methods, give substantially the same result.

SUMMARY OF THE ORBIT-ELEMENTS OF COMETS WHICH HAVE APPEARED SINCE 1860.

No.	Year	*T* [Paris M. T.]	π	Ω	i	log. q	e	Mot.	Computer.
		h m	° ′	° ′	° ′				
216 I	1860 I A	Feb. 16. 15 9	173 50	324 4	79 40	0.0788		D	I Pechule
216 II	1860 I B	Feb. 16, 16 14	173 45	324 3	79 36	0.0785		D	II Pechule
217	1860 II	Mar. 5, 13 44	50 5	8 53	48 13	0.1162		D	Gylden
218	1860 III	June 16, 1 18	161 32	84 41	79 19	9.4667		D	Auwers
219	1860 IV	Sept. 22, 7 38	356 48	44 51	82 12	9.8342		D	Kowalczyk
220	1861 I	June 3, 9 31	243 22	29 56	79 46	9.9641	0.96346	D	v. Oppolzer
221	1861 II	June 11, 12 19	249 5	278 59	85 26	9.9151	0.96508	D	Kreutz
222	1861 III	Dec. 7, 4 21	173 31	145 6	41 59	9.9238		R	Noether
(96) E	1862 I	Feb. 6, 5 59	158 1	334 31	13 5	9.5314	0.84670	D	v. Asten
223	1862 II	June 22, 0 53	299 20	326 33	7 54	9.9918		R	Seeling
224	1862 III	Aug. 22, 22 3	344 42	137 27	66 26	9.983		R	v. Oppolzer
225	1862 IV	Dec. 28, 4 20	125 11	355 46	42 29	9.9048		R	Krahl
226	1863 I	Feb. 3, 11 55	191 23	116 56	85 22	9.9002		D	Engelmann
227	1863 II	Apr. 4, 21 52	247 16	251 16	67 22	0.0286		R	Frischauf
228	1863 III	Apr. 20, 20 49	3 5 47	250 11	85 29	9.7965		D	Frischauf
229	1863 IV	Nov. 9, 11 50	94 43	97 29	78 5	9.8492		D	v. Oppolzer
230	1863 V	Dec. 27, 18 28	60 24	304 43	64 29	9.8873		D	Valentiner
231	1863 VI	Dec. 29, 4 17	183 8	105 2	83 19	0.1183		D	Rosen
232	1864 I	July 27, 19 38	188 53	174 59	45 0	9.7966		R	Kowalczyk
233	1864 II	Aug. 15, 14 0	304 12	95 15	1 52	9.9587	0.99635	R	Kowalczyk
234	1864 III	Oct. 11, 10 37	159 18	31 45	70 18	9.9690		R	v. Asten
235	1864 IV	Dec. 22, 10 59	321 41	203 13	48 53	9.8869		D	Kowalczyk
236	1864 V	Dec. 27, 17 26	162 24	340 54	17 7	0.0471		R	Valentiner
237	1865 I	Jan. 14, 7 58	141 16	253 3	87 32	8.4148		R	Tebbutt
(96) E	1865 II	May 27, 22 21	158 4	334 33	13 4	9.5327	0.84630	D	v. Asten
238	1866 I	Jan. 11, 3 22	60 28	231 26	17 18	9.9897	0.90542	R	v. Oppolzer
(163) F	1866 II	Feb. 18, 23 32	49 56	209 42	11 22	9.2259	0.55754	D	Moeller
239	1867 I	Jan. 19, 20 49	75 52	78 36	18 13	0.1966	0.84906	D	Searle
240 T_1	1867 II	May 23, 22 15	236 9	101 10	6 25	0.1941	0.50971	D	Sandberg
241	1867 III	Nov. 6, 23 15	276 22	64 59	83 26	9.5191		R	v. Oppolzer
(171) Br	1868 I	Apr. 17, 10 17	116 2	101 14	29 22	9.7760	0.80797	D	Schulze
242	1868 II	June 26, 11 35	285 38	52 15	48 27	9.7624		R	Karlinski
(96) E	1868 III	Sept. 14, 14 53	158 11	334 32	13 7	9.5233	0.84913	D	v. Asten
(131) W	1869 I	June 29, 22 44	275 55	113 33	10 48	9.8929	0.75190	D	v. Oppolzer
243	1869 II	Oct. 9, 20 39	123 17	311 30	68 20	0.0902		R	Kowalczyk
244 T_3	1869 III	Nov. 18, 19 25	42 58	296 44	5 24	0.0266	0.65813	D	Schulhof and Bossert
245	1870 I	July 14, 2 8	303 32	141 45	58 12	0.0038		R	Seydler
246	1870 II	Sept. 2, 4 53	17 53	12 56	80 39	0.2593		R	Gerst
(189) D'A	1870 III	Sept. 22, 16 46	318 41	146 25	15 39	0.1073	0.63487	D	Leveau
247	1870 IV	Dec. 19, 21 11	4 9	94 45	32 44	9.5902		R	Schulhof
248	1871 I	June 10, 14 33	141 50	279 19	87 36	9.8158	0.99781	D	Holetschek
249	1871 II	July 27, 0 59	115 34	211 54	78 1	0.0348		R	Cramer
(102) Tu	1871 III	Nov. 30, 11 18	116 5	269 18	54 17	0.0129	0.82105	D	Tischler
250	1871 IV	Dec. 20, 9 18	264 13	147 6	81 40	9.8397	0.99643	R	A. Lindhagen
(96) E	1871 V	Dec. 28, 19 33	158 13	334 34	13 7	9.5224	0.84935	D	v. Asten
(240) T_1	1873 I	May 9, 15 21	237 58	78 43	9 46	0.2484	0.46308	D	R. Gautier
251 T_2	1873 II	June 25, 5 9	306 6	120 57	12 45	0.1284	0.55260	D	Schulhof
(163) F	1873 III	July 18, 11 50	50 5	209 41	11 22	0.2260	0.55738	D	Moeller
252	1873 IV	Sept. 10, 18 58	36 48	230 35	84 1	9.8999	0.99647	R	R. Gautier
253	1873 V	Oct. 1, 18 28	302 58	176 43	58 31	9.5853		R	Weiss
(171) Br	1873 VI	Oct. 10, 11 49	116 5	101 15	29 25	9.7736	0.80883	D	Schulze
254	1873 VII	Dec. 3, 2 53	85 30	248 37	26 29	9.8895	0.77062	D	Weiss

No.	Year	T [Paris M. T.]	π	Ω	i	log. q	e	Mot.	Computer
		h m	° ′	° ′	° ′				
255	1874 I	Mar. 9, 22 35	299 48	30 18	58 53	8.6490		D	Wittstein
256	1874 II	Mar. 13, 22 37	302 22	274 7	31 35	9.9473		R	Wenzel
257	1874 III	July 8, 20 45	271 6	118 44	66 21	9.8208	0.99882	D	v. Hepperger
258	1874 IV	July 17, 16 57	5 27	215 51	34 8	0.2274	0.96283	D	Holetschek
259	1874 V	Aug. 26, 20 24	344 8	251 30	41 50	9.9924	0.99883	D	Gruss
260	1874 VI	Oct. 18, 22 47	265 41	281 58	80 47	9.7061		R	Holetschek
[131] W	1875 I	Mar. 12, 2 34	276 38	111 29	11 17	9.9185	0.74101	D	v. Oppolzer
[96] E	1875 II	Apr. 12, 23 58	158 17	334 37	13 7	9.5223	0.84942	D	v. Asten
261	1877 I	Jan. 19, 4 27	200 5	187 15	27 5	9.9071		R	Thraen
262	1877 II	Apr. 17, 15 54	253 29	316 37	58 51	9.9777	0.99870	R	Plath
263	1877 III	Apr. 26, 20 0	102 52	346 4	77 10	0.0040		D	Zelbr
[189] D'A	1877 IV	May 10, 8 9	319 7	146 7	15 43	0.1199	0.62780	D	Leveau
264	1877 V	June 27, 1 51	81 2	184 17	64 15	0.0296		R	Gruss
265	1877 VI	Sept. 11, 9 57	107 38	250 59	77 42	0.1977		R	Plummer
266	1878 I	July 20, 16 44	279 50	102 16	78 11	0.1436		D	Buettner
[96] E	1878 II	July 26, 2 56	158 20	334 39	13 7	9.5230	0.84917	D	v. Asten
[251] T_2	1878 III	Sept. 7, 6 25	306 8	121 1	12 46	0.1270	0.55869	D	Schulhof
[171] Br	1879 I	Mar. 30, 2 0	116 14	101 18	29 23	9.7708	0.80980	D	Schulze
267	1879 II	Apr. 27, 10 18	42 1	45 46	72 58	9.9529		R	Kremser
240 T_1	1879 III	May 10, 21 52	238 12	78 46	9 47	0.2483	0.46304	D	R. Gautier
268	1879 IV	Aug. 24, 5 58	308 12	32 22	72 15	9.9982		R	Hartwig
269	1879 V	Oct. 4, 15 16	202 38	87 11	77 8	9.9955		D	A. Palisa
270	1880 I	Jan. 27, 10 48	278 23	356 17	36 52	7.7714	0.99947	R	W. Meyer
271	1880 II	July 1, 17 54	112 3	257 15	56 56	0.2587		R	J. Mayer
272	1880 III	Sept. 6, 22 36	82 12	45 19	38 6	9.5498		R	Molien
[244] T_3	1880 IV	Nov. 8, 0 4	43 5	206 51	5 23	0.0282	0.65530	D	Schulhof and Bossert
243	1880 V	Nov. 9, 10 7	261 4	249 23	60 42	9.8193		D	Bigourdan
[163] F	1881 I	Jan. 22, 16 7	50 50	209 36	11 20	0.2401	0.54902	D	Moeller
274	1881 II	May 20, 10 38	300 12	126 24	77 58	9.7717		D	Gruss
275	1881 III	June 16, 10 46	265 13	270 58	63 26	9.8660	0.99643	D	Bossert
276	1881 IV	Aug. 22, 7 30	334 55	97 3	39 46	9.8018		R	Stechert
277	1881 V	Sept. 13, 10 36	18 36	65 52	6 50	9.8609	0.83041	D	Plummer
278	1881 VI	Sept. 14, 8 55	267 52	274 10	67 11	9.6524		R	Millosevich
[96] E	1881 VII	Nov. 15, 1 43	158 30	334 34	12 53	9.5353	0.84550	D	Backlund
279	1881 VIII	Nov. 19, 13 30	63 31	181 18	35 10	0.2847		R	Bigourdan
280	1882 I	June 10, 12 52	53 56	204 56	73 49	8.7836	0.99999	D	Parsons
281	1882 II	Sept. 17, 5 32	276 25	346 1	38 0	7.8895	0.99991	R	Kreutz
282	1882 III	Nov. 12, 23 51	354 48	249 7	83 51	9.9802	0.99923	R	Wolyncewicz
283	1883 I	Feb. 18, 23 1	29 2	278 6	78 6	9.8809		D	Bryant
284	1883 II	Dec. 25, 7 25	125 46	264 25	65 1	9.4909		R	H. Oppenheim
[124] P	1884 I	Jan. 25, 17 22	93 21	254 9	74 3	9.8897	0.95500	D	Schulhof
285	1884 II	Aug. 16, 10 54	306 11	5 11	5 27	0.1070	0.58246	D	and Bossert
286	1884 III	Nov. 17, 18 16	19 3	206 22	25 15	0.1964	0.55996	D	Berberich Krueger

244 T_3. A. N. 99: 13. Discovered November 27 by TEMPEL at Marseilles; observed till December 31 by BRUHNS at Leipzig, and by STRASSER at Kremsmuenster. A deviation from a parabola was suggested at this first short appearance, but it was not fully established till 1880, when after two revolutions, it was discovered for the second time by SWIFT. The elements com-

puted by CHANDLER, Jr. (A. N. 99: 46) in 1880 agree closely with these by SCHULHOF and BOSSERT above.

245. Wien. Ak. S. B. 64 (1871). Discovered May 29 almost simultaneously by TEMPEL at Marseilles and by WINNECKE at Carlsruhe; last observed July 9, at Athens, by SCHMIDT. The orbit by SEYDLER computed from seven normal places agrees very closely with one by DREYER (A. N. 80: 221) from six normal places. DREYER suspects a connection with certain Perseid radiants (A. N. 82: 289).

246. A. N. 80: 237. Discovered by COGGIA at Marseilles, August 28; last observed at Hamburg by PECHULE, December 23. An orbit designated by the computer as provisional—from five normal places.

(189) d'A. Annales de l'Observ. de Paris 14 p. B. 25. D'ARREST's periodic comet. Found August 31 by WINNECKE at Carlsruhe; last observed December 20, by SCHMIDT at Athens.

247. A. N. 85: 323. Discovered November 23 by WINNECKE at Carlsruhe, and observed for only a week; last, by RUMKER at Hamburg November 30. The fourteen observations available were brought together by SCHULHOF into four normals.

248. A. N. 84: 330. Discovered April 7 by WINNECKE at Carlsruhe, April 13 by BORELLY at Marseilles, April 15 by SWIFT at Marathon (New York). Last observed May 16 by SCHMIDT at Athens, and once after perihelion, August 5, at the Cape. In the above system of elements, the third computed by HOLETSCHEK, the Cape observations, are included, and the result is an ellipse with a period of 5188 years, to whlch, however, considerable uncertainty is attached.

249. Diss. inaug. Leiden 1875. "Berekening van de loopbaan der Komet 1871 II." Discovered by TEMPEL at Milan June 14; last observed by RUMKER at Hamburg September 20. Most probable orbit, computed very carefully from all the observations.

(102) Tu. A. N. 77: 255. Found October 12 by BORRELLY at Marseilles, October 15 by WINNECKE at Carlsruhe, October

22 by TUTTLE at Washington. Last observed, at Washington December 10, and also in the southern hemisphere, at the Cape, December 15, 1871 to January 30, 1872. First predicted return of comet 1790 II, re-discovered in 1858 by TUTTLE and BRUHNS.

250. A. N. 111: 112. Discovered November 3 by TEMPEL at Milan. The last European observation, November 18, was made at Hamburg by RUMKER, but the comet was observed, January 19 to February 17, 1872, at the Cape, and January 17 to February 20, at Cordoba (Argentina). In the above orbit by LINDHAGEN these observations after perihelion are included, but it seems impossible to satisfy all the observations by a parabola.

(96) E. Mem. de St. Petersb. 26 No. 2: 121. Found September 19 by WINNECKE at Carlsruhe, September 22 by HIND at Twickenham; picked up also by STEPHAN at Marseilles on September 18. Observed up to December 10 at Hamburg by PECHULE, and at Lund by WIJKANDER.

For a nebula found by TEMPEL at Milan on December 29, and taken for a comet, see A. N. 78: 383, 80: 27 and A. V. S.7: 98.

A comet was discovered by POGSON at Madras on December 2, and was observed by him on December 2 and 3, but it was only two evenings not seen elsewhere. Accounts and investigations in regard to it are to be found in A. N. vols. 80, 81, 84; in M. N. vol. 33, and in A. V. S. vol. 10. The comet was found through a telegram from KLINKERFUES, who had pointed out the probable visibility of BIELA's comet in that particular part of the heavens, since the radiant of the great meteor shower of November 27 in the northern hemisphere had shown a close agreement with the comet's place. Discussions, both in favor of and against the connection of this comet with the meteor shower and BIELA's comet have been published; those by v. OPPOLZER (A. N. 81: 281) and by BRUHNS (A. V. S. 10, 2) being of especial value.

(To be Continued.)

THE BIELA METEORS.

WM. W. PAYNE.

Most of our readers will remember that the meteoric shower of November 27, 1872, was predicted some time beforehand, as part of the remains of the Biela comet, which was not found in 1866, though most diligent search was made for it. At that time, two instances of the relation of comets and meteors had been established. In January, 1867, Dr. OPPOLZER, of Vienna, published an orbit of TEMPEL's comet, and within a few days, LEVERRIER published an orbit of the November meteors. The elements of these two orbits agreed so nearly that the comet and the meteors were believed to move in the same path. A re-discussion of this interesting problem by Professor DANIEL KIRKWOOD, published in MESSENGER No. 38 brings out very clearly the striking fact that the meteors in this path are moving in three distinct groups, designated by the letters A, B and C; and that the next return of the several bodies may be expected at the times indicated below:

TEMPEL's Comet I (1866)	1899
The A group of meteors	1899 to 1901
The B " " "	1886 to 1889
The C " " "	1912 to 1915

As soon as it was known that the November meteors and TEMPEL's comet were moving in the same orbit it was also learned that SCHIAPARELLI, an Italian astronomer, had come to a similar conclusion respecting the August meteors and the second comet of 1862. In view of the difficulty of observing accurately the radiant point of a stream of meteors, and also the uncertainity of the period of the last named comet because of the ellipticity of its orbit, it is surprising that the computed orbits of the comets and meteors of these two cases agree as nearly as they do.

In the meteors of November 27 and BIELA's comet we have a third instance of these apparently dissimilar bodies moving in

the same path. The history of this system is brief, but intensely interesting. This comet was first seen by BIELA in Bohemia, February 27, 1826; then thought to be identical with the comet of 1805, for which GAUSS had computed an elliptic orbit, the more correct elements of which showed a periodic time of six years and nine months. By tracing back its orbit observations were found as early as 1772, showing a fair agreement of place. Its ninth return was then predicted for November 26, 1832, and "it* passed its perihelion in exact accordance with the prediction". Though faint, it was seen for three months and finally disappeared January 3, 1833. In 1839 its return was not observed because, in position, it was unfavorably near the *Sun*. On its eleventh appearance, the comet was first seen by DE VICO, at Rome, November 26, 1845. It was visible until April following, passing its perihelion on the 11th of February, 1846. About the middle of December preceding, the comet gave strong indication of a violent change in form; a few days later an attendant nebulous patch was seen at a small distance from the comet, and on January 15 two distinct comets were observed traveling side by side. The gradual increase in the companion comet and the fading of the parent nucleus, the arched and swaying bridge of light between them, the frequent reverse of brilliancy in the two comets, and in March of that year, the apparent re-union of them were some of the astonishing phenomena that met the observer's gaze. This battle of comets at a distance from 100,000 to 200,000 miles apart continued for three months, and until both disappeared from sight.

In 1852, the comets were again seen traveling one and one-half millions of miles apart, and although separated so widely, it was impossible to tell which was the original comet of 1846. They were observed from August 26 to September 28. The companion comets were in unfavorable position for observation in 1859, and so were not seen. In consequence of this the next return in 1866 was anxiously waited for, and though diligently sought, under most favoring circumstances, the BIELA comets were not then found, nor have they since certainly been seen.

At the time of next return on November 27, 1872, an unus-

*Watson on Comets,

ually brilliant star shower appeared, with radiant point in the constellation of *Andromeda*, and hence the meteors have been generally called *Andromedes*. It was then noted that shooting stars in considerable numbers were seen from the same radiant point on December 7, 1798, and December 8, 1838. Immediately after the shower of 1872 POGSON discovered a small comet in the opposite part of the heavens from the radiant of these meteors, which was moving, in nearly the same orbit, and which could be neither of the lost twin comets.

It is probable that the *Andromedes* are older than the disruption of BIELA's comet, and very probable that the POGSON comet was much older, if ever a part of the parent mass. The next return of the shower was looked for in 1879 and 1880, but so far as we know there was no display.

The latest shower of the BIELA meteors occurred November 26 to 29, 1885, which was unusually brilliant and very geuerally observed. We have given large space to the reports from different parts of this country.

THE COMETS 1812 I, AND 1846 IV.

DANIEL KIRKWOOD.

Attention has been more than once called to the striking resemblances between the orbits of these bodies* — a resemblance too close to be regarded as accidental. "According to the theory now generally accepted, comets enter the solar syetem *ab extra*, move in parabolas or hyperbolas around the *Sun*, and, if undisturbed by the planets, pass off beyond the limits of the *Sun's* attraction to be seen no more. If in their motion, however, they approach very near any of the larger planets, their direction is changed by planetary perturbation,—their orbits being sometimes transformed into ellipses. The new orbits of such bodies would pass very nearly through the points at which their greatest perturbation occurred; and accordingly we find that the aphelia of a large proportion of the periodic comets are near the orbits of the major planets." Those of the com-

* Comets and Meteors, Chap. III, and Pop. Sci. Monthly, Feb., 1884, p. 49.

ets 1812 I, and 1846 IV, are near the path of *Neptune*. These comets, therefore, in all probability, owe the present form of their orbit to that planet's disturbing influence. At what epoch was this transformation effected?

The aphelion longitude of the Pons-Brooks comet (1812) is about 256°. *Neptune* had this mean longitude A. D. 1814.5, 1649.88, 1485·26, 1320.64, 1156.02, 991.4, etc. The comet of 1812 was in aphelion about 1777.1. But $1777.1-991.4=785.7=11\times71.4+$. That is, *Neptune* and the comet of 1812 were in the same longitude in A. D. 991. The elliptic form of the cometary orbit probably dates from that epoch.

The fourth comet of 1846 was in aphelion in 1809. The interval between 991 and this date was 818 years, or eleven periods of about seventy-four years. This differs by less than a year from PEIRCE's value.

Opinions of NORMAN R. POGSON, *C. I. E., F. R. A. S. Government Astronomer at Madras, on American Astronomical Instruments; Extracted from his recently published volume on Telegraphic Longitude Determinations in India.*

[Communicated by Professor C. PIAZZI SMYTH, Astronomer Royal of Scotland.]

On page 2 occurs the following:—

"The need of a good cylinder chronograph for other (than longitude) purposes, especially for investigation of the solar parallax by means of observations of the planet *Mars* in opposition, for which Madras Observatory is above all others the most favorably situated in the world, was often urged, but to this day nothing of the kind has been supplied, except a French tape recorder, sent out in November, 1874, for the transit of *Venus*, due in the following month;—a mere toy which no astronomer would care to possess and which has never been of the slightest use since its arrival.

"The chronographs now constructed by leading American and British makers are as near perfect as can be desired, and enable inexperienced observers to make records, equal, if not

superior to those obtainable by long practiced observatory assistants without such aid; while in cases in which numerous times have to be noted, in more rapid succession than any one could possibly accomplish by the old eye and ear method, they are simply indispensable. American chronographs seem to me preferable for their greater simplicity, having only pen or pencil for both clock seconds and observer's records, instead of two, separately marking side by side; and also in their being worked by a portable chronometer, just as readily as by a fixed astronomical clock.

Also on page 12:—

Speaking of longitude observations at Singapore, by Lieut. Commodore H. DAVIS and Lieut. J. A. MORRIS of U. S. Navy, in January, 1882, Mr. POGSON writes:—

"The exquisite instruments I had the pleasure of seeing employed here by my esteemed American friends, Messrs. DAVIS and LEENLEY, as well as the skilled way in which they were handled, were the realization of what I had hoped for when I first made my own proposals to Government for latitude determinations upon my arrival in India. Perfection of accuraate symplicity, eschewing all affectation of needless refinement, seems to be the distinguishing characteristic of American scientific instruments, and researches in general, and of such nature were the appliances and methods used upon this occasion."

MEASURES OF THE VELOCITY OF LIGHT.*

When it became clearly understood that vision was not an immediate perception of objects by the eye, but was produced by the passage of an entity called light from the object to the eye, the question of the time which might possibly be required for this passage became one of interest to physical investigators. The first proposal for an experimental investigation of this question is due to GALILEO.† He suggested that two observers,

*Introduction to Parts III and IV of Vol. II of Astronomical papers, by Professor Simon Newcomb.

†Poggendorff Geschichte der Physik p. 402, where reference is made to the Saggi of the Florentine Academy.

each holding a lantern, should be stationed at a distance apart, in sight of each other. Each should be supplied with a screen, by which he could, in a moment, cover or uncover his lantern. One observer should then uncover his lantern and the other uncover the other the moment he perceived the light from the first lantern. The interval which elasped after the first uncovered his light, until he perceived the light of the second, would be the interval required for the light to go and come, plus the time required for the second observer to perceive the light and make the required movement. This experiment was tried by the Florentine Academy, and of course resulted in a conclusion that the time required was insensible, since we now know that it was far below any interval that could have been detected by so rude a method.

It is, however, interesting to notice that, rude though this experiment was, the principle on which it was based is the same which underlies one of the most celebrated methods used in recent times for the attainment of the same object. Two very simple improvements which we might have imagined the academicians to make in their experiments are these:

Firstly, to dispense with the second observer, and in his place to erect a mirror, in which the first observer could see the image of his own lantern by reflection. The time required for the second observer to perceive the light and uncover his lantern would then have been eliminated from the problem. The interval sought would have been that between the moment at which the observer uncovered his lamp and the moment at which he perceived the reflection.

Secondly, to use the same screen with which he uncovered his own lamp to cut off the returning ray from the distant mirror, and thus obviate the necessity of an uncertain estimate of the interval between his muscular effort in removing the screen and his perception of the return flash of light. If the image was perceived before he could cover his own eye with the screen removed from the lamp, it would show that the interval of passage was less than the time required to make a motion with the screen. This interval might have been reduced almost indefinitely by having both lines of sight as near together as possible.

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Had these improvements been made the academicians would have had, in principle, FIZEAU's method of measuring the velocity of light by the toothed wheel, a tooth being represented by the screens. To realize the principle more fully, the two lines of sight should have been rendered absolutely coincident by reflection through a telescope. It does not, however, appear that any effort to put the question to a severer test was made until the subject was approached from a different point of view. It was probably considered that the passage was absolutely instantaneous, or, at least, that the velocity was above all powers of measurement.

The subject was next approached from the astronomical side. In 1676 ROEMER made his celebrated communication to the French Academy, claiming that observations of the eclipses of the first satellite of *Jupiter* did really prove that light required time to pass through celestial spaces.* He found $11m$ to be the time required for light to pass over a distance equal to the radius of the *Earth's* orbit. DOMINIQUE CASSINI while admitting that the hypothesis of ROEMER explained the observed inequality, contested its right to reception as an established theory, on the ground that the observed inequality might be a real one in the motion of the satellite itself.†

Continued observation showed that the time assigned by ROEMER for the passage of light between the *Earth* and *Sun*, or "the light equation" as it is briefly called, was somewhat too great. In 1809 it was fixed by DELAMBRE at $493.2s$ from an immense number of observations of eclipses of *Jupiter's* satellites during the previous 150 years. This number has been received as a definitive result with a degree of confidence not at all warranted. In 1875, GLASENAPP, then of Pulkowa, from a discussion of all available eclipses of *Jupiter's* first satellite between 1848 and 1870 showed that results between $496s$ and $501s$

* Paris Memoirs, tome i., page 212, and tome x., page 575.

† Ibid, tome viii., page 47. Poggendorff (Geschichte der Physik, page 656) quotes Maraldi as also contesting Roemer's explanation on the ground that a similar inequality should be found depending on the position of Jupiter in his orbit. The ground here taken was quite correct; the only fallacy being the assumption that such an inequality did not exist.

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could be obtained from different classes of these observations by different hypotheses.*

As not a trace of DELAMBRE'S investigation remains in print, and probably, not in manuscript, it is impossible to subject it to any discussion.†

The discovery of aberration by BRADLEY afforded an independent and yet more accurate method of determining the light equation. We call to mind that the latter constant, and that of aberration, are not to be regarded as independent of each other, but only as two entirely distinct expressions of the same result. The constant of aberration gives a relation between the velocity of light and the velocity of the *Earth* in its orbit from which, by a very simple calculation, the time required for light to pass from the *Sun* to the *Earth* may be deduced.

It is remarkable that the early determination of the constant of aberration agreed with DELAMBRE'S determination of the light equation, although we now know they were both in error by an amount far exceeding what was, at the time, supposed probable. STRUVE'S value, 20.″445, determined in 1845 from observations with the prime vertical transit of Pulkowa, has been the standard up to the present time. The recent determinations by NYREN being founded on a much longer series of observations than those made by STRUVE, and including determinations with several instruments, must be regarded as a standard at present. ‡His result is:

Definitive value of the constant of aberration = 20.″492 ± 0.″006.

(To be Continued.)

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* This paper of Glasenapp's was published only in the Russian language as an inaugural dissertation, and in consequence has never become generally known.

† The author could find no remains of this investigation among Delambre's papers at the Paris Observatory.

‡ Memoires de l'Academie Imperiale des Sciences de St. Petersbourg, vii serie, tome xxxi, No 9.

Observations of Comets at the U. S. Naval Observatory by Profs. Hall, Frisby and Winlock. The Observations of Prof. Hall were made on the 26-inch Equatorial, the Others on the 9.6-inch Equatorial.

(Communicated by Commodore Geo. E. Belknap, U. S. N. Supt.)

COMET III., 1884.—(Wolf.)

Date 1885	Mean Time	Δα	Δδ	Comp.	App. α	log. Δp	App. δ	log. Δp	Star	Obs.
Jan. 10	7h 32m 15s	+1m 15.05s	−1′ 57.1″	20.4	1h 5m 5.94s	9.329n	− 5° 40′ 39.8″	0.786″	1	F
12	6 56 39	+1 22.33	+7 17.2	19.4	1 10 4.27	9.189	− 5 31 53.1	0.787	2	F
13	6 37 1	+0 41.27	−2 30.5	15.3	1 12 31.12	9.070	− 5 27 33.5	0.788	3	F
22	7 52 21	+1 7.52	−0 58.2	20.4	1 32 32.68	9.438	− 4 44 55.1	0.776	4	F
22	7 17 7	+3 32.10	+4 38.2	20.4	34 57.24	9.336	− 4 39 18.7	0.778	4	F
26	7 26 20	+0 5.80	+1 32.4	20.4	1 44 47.18	9.386	− 4 14 29 9	0.776	5	F
Feb. 3	9 4 17	−0 39.15	+0 27.0	20.4	2 6 23.25	9.596	− 3 21 24.5	0.760	6	F
11	8 33 29	−0 57 95	+3 11.7	20.4	2 23 28.67	9.575	− 2 44 46.9	0.755	7	F
16	8 22 43	−0 8.58	−4 39.6	15.3	2 35 18.01	9.571	− 1 49 3.2	0.752	8	F

COMET ENCKE.

Jan. 21	7h 29m 58s	−1m 49.24s	+1′ 15.7″	5.1	23h 17m 40.84s	9.622s	+ 5° 25′ 52.4″	0.718″	9	F
22	7 45 23	−0 32.43	+7 22.4	19.4	23 18 57.64	9.635	+ 5 31 59.0	0.721	9	F
29	6 50 9	−1 31.66	+1 22.1	10.2	23 28 51.51	9.601	+ 6 14 35.5	0.709	10	F
Feb. 3	7 8 6	+0 19.95	+9 19.6	15.3	23 36 24.77	9.630	+ 6 46 11.5	0.714	11	F
10	7 2 5	−2 29.10	−12 33.2	15.3	23 47 15.29	9.639	+ 7 22 27.0	0.742	12	F
11	8 19 8	−1 0.13	−8 45.8	15.3	23 48 44.26	9.666	+ 7 26 14.3	0.739	12	F
12	7 25 42	+0 25.91	−5 35.1	20.4	23 50 10.30	9.655	+ 7 29 25.0	0.724	12	F
16	7 1 9	+5 57.75	−0 45.5	10.2	23 55 42.10	9.648	+ 7 34 14.2	0.718	12	F
17	6 42 42	+7 11.08	−2 24.6	10.2	23 56 55.43	9.645	+ 7 32 35.0	0.716	12	F

COMET 1885.—Barnard.

July 30	9h 39m 46s	+0m 3.37s	−1′ 35.4″	15.3	16h 45m 8.76s	9.268s	−17° 17′ 27.5″	0.855″	13	F
31	8 58 37	−0 45.33	−1 12.1	20.5	16 44 0.74	9.052	−17 45 28.3	0.864	14	H
31	9 56 21	−0 47.82	−2 24.8	17.4	16 43 58.25	9.344	−17 46 41.0	0.857	14	F
Aug. 5	9 13 15	−1 26.56	−12 57.0	10.2	16 38 46.83	9.289	−20 6 10.5	0.867	15	F
6	9 7 13	+0 58.66	−4 17.7	15.3	16 37 51.51	9.285	−20 32 53.3	0.869	16	H
10	9 16 26	+3 15.65	.....	10.	16 34 32.33	9.410	.....	.....	17	H
12	8 28 1	−1 12.59	−0 37.1	16.4	16 33 8.48	9.241	−23 6 30.6	0.882	18	H

COMET 1885.—Brooks.

Sep. 6	8h 9m 29s	−1m 6.30s	−4′ 39.9″	19.3	14h 4m 33.70s	9.758s	+38° 28′ 0.5″	0.531″	19	W
12	9 16 37	+2 19.18	−8 40.7	10.2	14 41 36.20	9.783	+40 48 13.9	0.630	20	F

ADOPTED POSITIONS OF COMPARISON STARS.

Star.	R. A. 1885.0.	δ 1885.0.	Reduction.	Authority.
1	1h 3m 50.74s	− 5° 38′ 37.1″	+0.15s − 5.7″	Weisse, 1h, 12.
2	1 8 41.78	− 5 39 4.4	+0.16 − 6.0	Schj., 396.
3	1 11 49.68	− 5 24 56.9	+0.17 − 6.1	Schj., 409.
4	1 31 24.98	− 4 43 49.6	+0.18 − 7.2	Weisse, 1h, 514.
5	1 44 41.18	− 4 15 54.4	+0.20 − 7.9	Weisse, 1h, 768.
6	2 7 2.17	− 3 21 42.7	+0.23 − 8.9	Schj., 636.
7	2 24 26.40	− 2 27 49.0	+0.22 − 9.7	Schj., 761.
8	2 35 26.39	− 1 44 13.5	+0.20 −10.1	Weisse, 2h, 588.
9	23 19 30.49	+ 5 24 35.4	−0.41 + 1.3	Schj., 9650.
10	23 30 23.56	+ 6 13 12.7	−0.39 + 0.7	Schj., 9738.
11	23 36 5.24	+ 6 36 51.9	−0.42 0.0	Yarnall, 10476.
12	23 49 44.78	+ 7 35 0.9	−0.39 − 0.8	Schj., 9920.
13	16 45 2.45	−17 15 57.2	+2.94 + 5.1	Wash., T. C.
14	16 44 43.16	−17 44 21.2	+2.91 + 5.0	O. A. S., 16024.
15	16 40 10.51	−19 53 17.5	+2.88 + 4.0	Yarnall, 6923.
16	16 36 49.98	−20 28 39.3	+2.87 + 3.7	Yarnall, 6902.
17	16 31 13.83	.....	+2.85	O. A. S., 15779.
18	16 34 18.22	− 23 5 56.0	+2.85 + 2.5	O. A. S., 15827-8.
19	14 5 39.77	+38 32 32.4	+0.23 + 8.0	M. [2] 14h, 77-78.
20	14 39 16.73	+40 48 13.9	+0.29 +10.6	M. [2] 14h, 811-813.

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EDITORIAL NOTES.

Volume V begins with full reports of topics of present general interest. Many subscribers have anticipated its first issue by encouraging words and a renewal of subscription. This number is sent to the list of 1885.

The two new comets and the Biela meteors have been observed and talked about in all parts of the world. Some exceedingly interesting matter concerning the computation of the orbits of meteor streams is deferred until our next number.

So much interest has been manifested, at home and abroad, in the English translation of Dr. GALLE'S Catalogue of recent comets, by W. C. WINLOCK of the Naval Observatory, Washington, D.C., that we have decided to reprint a small edition of the catalogue during the present month, for the benefit of all interested in cometary astronomy. So far as we know, more information concerning recent comets is contained within the limits of 25 pages than is elsewhere found in English. At sight it is evident that the translation has been in very competent hands.

This Catalogue, in pamphlet form, will be mailed to any address on receipt of fifty cents.

On the Titles of Contributions to Astronomical Periodicals. Reply to X. Y. Z. in No. 38.

Your esteemed correspondent is right, when he declares it desirable that the titles of articles be precise and so stated that the reader can from the titles judge of the contents of the articles.

So far as the *Astronomische Nachrichten* is concerned, I have taken pains in the index of the volumes to remedy this defect. In the index the reader is fully informed concerning the contents of the articles, even when over the original article only a heading which may be termed general is found. Nevertheless I will gladly yield to the wishes of your contributor, and in future remember, in regard to such articles as are communicated in the form of a letter, to indicate, at once, in the heading the subject matter.

A. KRUEGER.

ROYAL OBSERVATORY, KIEL.

A new comet was discovered in Paris December 1.3924, Gr. M. T., in R. A. $0^h\ 39^m\ 8.5^s$: Decl. $+21^\circ\ 2'\ 25''$. Daily motion in R. A. $-2^m\ 28^s$; in Decl. $-3'$.

Science Observer Circular No. 61 gives the following observations, and elements:

Gr. M. T.	App. α	App. δ	Observer
$d\ \ h\ \ m\ \ s$	$h\ \ m\ \ s$	$\circ\ \ '\ \ ''$	
Dec. 1 9 25 4	0 39 8.5	+21 2 25	Paris.
2 11 52 45	36 26.42	21 0 30.4	Wendell, H. C. O.
2 13 42 9	36 15.68	21 0 25.6	Egbert, Albany.
2 14 28 11	36 11.10	21 0 20	Frisby, Washington
2 16 34 35	35 57.70	21 0 13.	Wendell, H. C. O.
3 12 54 48	33 56.28	20 58 51.8	Wendell, H. C. O.
3 16 20 17	33 35.73	20 58 36.3	Wendell, H. C. O.
5 18 18 57	28 44.51	20 55 8.2	Chandler, H. C. O.
6 3 14 53	26 57.43	20 53 56.1	Wendell, H. C. O.
7 12 51 54	24 46.01	+20 52 34.9	Schæberle, Ann Arbor.

From the above observations the following orbit has been computed, by Messrs. CHANDLER and WENDELL:

ELEMENTS.

$T = 1886$, March 15.494, Gr. M. T

$\Omega = 33^\circ\ 36'.6$ $\quad \delta\lambda \cos\beta = -1''$

$\pi - \Omega = 133\ 17.$ $\quad \delta\beta = -17''$

$i = 56\ 49.6$

$\log. q = 9.69050$

On account of the large distance of the comet and its considerable anomaly ($v = 120^\circ$) the orbit is somewhat indeterminate, several attempts failing to reduce the residual below the figures given, and there is some suspicion that the orbit is elliptical.

Light December 1 = unity.

The comet is faint, 2′ in diameter, with central condensation; 12 magnitude.

COMET BARNARD (II) 1885 D.

December 3 $9^h\ 37^m$, Wash. M. T., E. E. BARNARD, Vanderbilt University, Nashville, discovered a faint telescopic comet, whose R. A. was $4^h\ 21^m\ 57^s$; Decl. $+4^\circ\ 45'$, having daily motion northwest $35'$, as reported from H. C. Observatory.

Respecting the discovery, Mr. BARNDRD says:

"On the night of December 3, while searching near *Orion* with the 6-inch refractor, I came across what I instantly recognized as a comet, being perfectly familiar with all the nebulæ in that region. A

half hour's time confirmed the cometary character of the object. Ring micrometer comparisons with an unknown ninth magnitude star were made. The following night being cloudy, on the evening of the 5th comparison with the same star was made, the comet's declination having changed so little. At this time an exceedingly small and faint star-like nucleus was seen in the preceding part of the nebulosity. On account of cloudy skies no positions could be secured until the 9th. The motion of the comet is nearly due west, and only slightly to the north. On the night of discovery this comet passed almost centrally over a small star, which shone through the nebulosity, without probably any diminution of luster." E. E. B.

VANDERBILT UNIVERSITY OBSERVATORY, December 10th, 1885.

The following positions of the above comet have been secured, and from those between December 5 and 10, the orbit given below has been computed by Messrs. CHANDLER and WENDELL as published in *Science Observer* Circular 62:

Gr. M. T.				App. α			App. δ			Observer
	d	h	m	s	h	m	s	°	′	″	
Dec.	3	14	45		4	21	57.0	+4	45		Barnard, Nashville.
	5	16	37	56		16	58.30		54	14.6	Barnard, Nashville.
	5	16	13	58		16	38.80		54	47.8	Chandler, Harvard.
	6	12	57	25		14	52.40	4	58	30.6	Wendell, Harvard.
	7	12	58	21		12	25.93	5	4	2.6	Wendell, Harvard.
	10	20	9	30		4	17.15		23	15.0	Wendell, Harvard.
	11	11	9	52	4	2	43.67	+5	27	11.4	Wendell, Harvard.

ELEMENTS.

T=1886, June 4.066, Greenwich M. T.

$\pi - \Omega = 108° 24'.8$
$\Omega = 63\ 13.8$ } 1885.0
$i = 108\ 30.8$

$C - O$
$\delta\lambda \cos\beta = +5''$
$\delta\beta \quad = +9''$

$\log. q = 9.86877$

Light on December 3—unity

The comet is faint, with a 12th mag. nucleus, eccentrically placed near the preceding part of the coma.

On December 31 the comet was about 8° almost directly south of a third magnitude star known as Gamma in the *Hyades* of *Taurus*.

Professor SWIFT, of Warner Observatory, recently published in A. N. No. 2693 a catalogue of one hundred new nebulæ. He is now re-observing another list of new nebulæ, numbering one hundred and twenty

Observations of the Biela Meteors at Princeton, N. J. on November 27th. By PROF. C. A. YOUNG.

Between 7:15 and 8:00 (Eastern Standard time) about one hundred meteors were recorded by one observer.

The number fell off rapidly from the beginning: I counted thirty-six in the first ten minutes, although I was then walking under trees and among buildings, which hid a large part of the sky; while during the last ten minutes, under an open sky, I saw only four. Probably, therefore, the maximum must be set as early as 7:30, if not before 7:15. I regret that I did not look out for the meteors earlier in the evening: but other matter, during the day had quite driven them out of my mind.

The radiant was well marked, an oval space about 4° long (north and south) and about 2° wide. I estimated its center to be about 2° northwest of Gamma *Andromedæ*; A. R. $1^h\ 50^m$, Decl. 43.°5, with a probable error of $\pm \frac{1}{2}°$.

The determination rests upon three nearly stationary meteors observed actually within the limits of the oval, confirmed by the projection of about twenty other meteor paths in the immediate neighborhood.

Very few of the meteors seen were seriously unconformable, though a few (perhaps five or six) had paths strongly curved or irregularly crooked.

About half-a-dozen of the whole hundred were of the first magnitude, about fifty, of the second or third. A large proportion of the remainder were very small — of the fifth or sixth: and there were numerous glimpses of minute meteors, caught only by averted vision; not fairly seen, and so not counted.

Most of the paths were short — less than 10° or 15°, and the motion was generally rather slow. Many of the brighter ones showed evanescent trains, never lasting more than two or three seconds. Whenever any color was visible in the meteor or its train, it was always reddish — never greenish or bluish as in the case of the Leonids.

Professor G. W. HOUGH'S report of Dearborn Observatory, Chicago, is received. His studies of the physical features of the planet *Jupiter* are continued, and in connection with the six years of work preceding, on the same theme, furnishes probably, the most definite knowledge respecting the markings of *Jupiter*, which has been given to astronomy. His article in MESSENGER No. 40 contains results of late work.

Though the red spot was fainter at the two oppositions preceding the last, it has never disappeared entirely from view.

Mr. BARNARD recognizes the nebula in *p.* end of *Andromeda* nebula as G. C. 106; not new as stated in October MESSENGER.

XUM

Volume XLVIII, of the Memoirs of the Royal Astronomical Society, in parts I and II, 1884, contains a series of papers of interest to astronomy. The first part is devoted to the study of parallax of nine stars in the southern hemisphere by Messrs. GILL and ELKIN. The following table gives final results:—

Star	Observer	Parallax	Probable Error	Mag. of Comp. Star
α Centauri	Gill & Elkin	+0.″75	±0.″01	7.6
Sirius	" " "	+ . 38	. 01	7.5
Epsilon Indi	" " "	+ . 22	. 03	7¼
Lacaille 9352	Gill	+ . 28	. 02	7.6
Omicron$_2$ Eridani	"	+ . 166	. 018	6.4
Beta Centauri	"	— . 018	. 019	7.
Zeta Tucanæ	Elkin	+ . 06	. 019	7½
ϵ Eridani	"	+ . 14	. 020	6.4
Canopus	"	+ . 03	. 030	8.

Following the discussion of the observation of these stars is a series of pertinent precautions, suggested by these experienced observers, to eliminate systematic errors in future investigations of the same kind. In the conclusion of this paper, the authors remark that "the great cosmical questions to be answered are not so much what is the precise parallax of this or that particular star, but:

1. What are the average parallaxes of those of the first, second, third, and fourth magnitude, respectively, as compared with those of lesser magnitudes?

2. What connection exists between the parallax of a star and the amount and direction of its proper motion? Can it be proved that there is no such relation?

Part II contains the fourth catalogue of micrometrical measures of double-stars made at the Temple Observatory, Rugby, by G. M. SEABROKE; a paper on the relative proper motion of forty stars in the *Pleiades*, determined from micrometrical and meridional observations by Professor C. PRITCHARD; observations of *Mars* at opposition in 1884, by E. B. KNOBEL; on the corrections required by HANSEN'S Tables de la Lune, by EDMUND NEISON and two others.

We are sure that this publication, of the Royal Astronomical Society, will be desired generally by American astronomers.

Messrs. WARNER and SWASEY, of Cleveland, Ohio, have lately completed a new 6-inch equatorial of the "Lick" pattern for Professor H. S. PRITCHETT, of Washington University, St. Louis. Full description will appear in oue next.

NEW NEBULÆ.

I have found the following nebulæ with the 6-inch Cook equatorial of this observatory:

R. A. = $3^h\ 13^m\ 21^s$ } 1886.0
Decl. = $-28°\ 2'.4$ }

Rather faint, moderate size, elongated nearly north and south, just south and slightly *p.* a small wide double-star.

R. A. = $4^h\ 54^m\ 7^s$ } 1886.0
Decl = $-11°\ 18'.3$ }

Three small novæ close together, difficult; rather faint, all three prabably elongated north and south. The place is that of the preceding of the three nebulæ. A good many stars in field. It requires considerable power to make these nebulæ out distinctly, a power of 120 on the 6-inch is about the lowest with which they can be seen. Mean of three equatorial pointings.

R. A. = $4^h\ 54^m\ 37^s$ } 1886.0
Decl. = $-11°\ 9'$ }

The R. A. might be 1^m too great. The position is from one equatorial pointing. This lies between two small stars and is in field with the three nebulæ mentioned above. The two stars form the preceding side of a beautiful small triangle, the three stars nearly equal. This nebula is not large. Round v g b M. I have since been informed by PROF. SWIFT that this nebula was discovered by TEMPEL, probably in 1882.

R. A. = $5^h\ 3^m\ 4^s$ } 1885.0
Decl. = $+47°\ 31'$ }

Small hazy spot, with high power (120) seems to be some faint stars mixed up in nebulosity, a small star involved *f.* It is followed some little distance by a 9th magnitude star. E. E. BARNARD.

VANDERBILT UNIVERSITY OBSERVATORY, NASHVILLE, TENN., Nov. 30, '85

THE ALMUCANTAR.

Mr. ROCKWELL has reason to esteem his new instrument highly. In a recent letter he says:—

"I give below the results of *one* evening's work for latitude, August 8th, 1885. Corrections to 41° 04' 12."5 (assumed).

Lambda *Acquilæ*	east	+0."509
" "	west	+0. 462
Eta *Aquarii*	east	−0. 297
Gamma "	east	+0. 277
Beta "	east	−0. 204
Eta *Serpentis*	west	+0. 371

CHAS. H. ROCKWELL.

The Biela Meteors.

On Friday evening, 27th inst, a very considerable meteoric shower was noticed. Between the hours of 6 and 9 p. m. observations were made at intervals of a few moments each, other duties preventing continuous watching. At these times the meteors were seen falling in all parts of the sky, sometimes singly and sometimes several nearly simultaneously They were mostly small, with short paths, but occasionally some brilliant ones were noticed which left bright trails behind them, lasting a few seconds. The radiant point was evidently in *Andromeda* and one which appeared to glow out near the centre of the constellation, showed by the direction of the extremely short distance it appeared to move that this point was located near the feet of the constellation. Judging by the numbers seen during the brief observations, many hundreds must have entered our atmosphere during the continuance of the shower.

BAYONNE, N. J., November 30, 1885. JOHN H. EADIE.

Observations of 23 B. A. C. Stars Employed by the U. S. Coast and Geodetic Survey in 1873 to determine the latitude of Madison, Wisconsin.

[The observations were made by Mr. Comstock and Mr. Updegraff at the Washburn Observatory in June and July, 1885.]

B. A. C. number of star.	Approximate R. A.	Observed Decl. 1885.0	Prob. error mean	Prob. error 1 obs.	No. of Obs.
5950 *pr*	17*h* 29*m* 54*s*	+55° 15′ 47.″72	0.″09	0.″26	9
5962	32 14	+30 51 23. 37	0. 16	0. 48	9
5990	36 14	+46 4 4. 46	0. 11	0. 34	11
6062	48 2	+40 0 27. 23	0. 17	0. 51	10
6079	51 32	+56 53 27. 52	0. 13	0. 40	11
6084	17 53 17	+29 15 38. 27	0. 07	0. 22	10
6224	18 13 12	+64 21 30. 42	0. 08	0. 27	11
6251	18 47	+21 43 4. 93	0. 11	0. 40	12
6476	18 54 48	+57 39 45. 54	0. 11	0. 34	10
6547	19 2 4	+28 26 53. 99	0. 12	0. 37	12
6651	19 58	+36 13 *			
6659	20 23	+50 2 48. 60	0. 12	0. 36	9
6687	24 37	+52 5 11. 70	0. 11	0. 36	11
6698	27 30	+34 12 31. 58	0. 09	0. 26	10
6741	34 45	+49 1 6. 51	0. 09	0. 28	11
6771	40 8	+37 4 36. 58	0. 09	0. 28	10
6784	42 4	+33 27 37. 27	0. 09	0. 26	10
6824	47 45	+52 41 47. 45	0. 07	0. 22	11
6895	19 58 6	+49 47 5. 71	0. 14	0. 46	11
6937	20 5 10	+36 30 4. 98	0. 04	0. 14	10
6983	11 55	+47 21 41. 07	0. 12	0. 39	10
7008	16 5	+39 2 26. 96	0. 09	0. 30	11
7067	24 42	+29 59 6. 71	0. 11	0. 34	10
7105	20 28 58	+56 23 21. 75	0. 08	0. 23	10
		Mean	±0.10	±0.32	10.4

* Will be observed at Harvard College Observatory.

An Excessively Faint Nebula.

On the night of November 3, I found an excessively faint, but rather large nebulosity that is not in G. C. or supplement. This nebula lies a short distance following and south of a 9th magnitude star. It seems to be extended somewhat. It is probably about ½° long. An equatorial pointing gave its place

$$\left.\begin{array}{l}\text{R. A.}=3^h\ 56^m\ 1^s \\ \text{Decl.}=+36°\ 6'\end{array}\right\} 1886.0$$

This requires the lowest power and cannot be seen by direct vision. It is only by directing the vision slightly to one side of its place that it is possible to see it, it then flashes out feebly.

E. E. BARNARD.

Professor C. Piazzi Smyth, Astronomer Royal of Scotland, kindly sends us a few paragraphs which appear on another page, showing how a distinguished foreign astronomer, N. R. Pogson, Madras Observatory India, looks upon American observers and American astronomical instruments. Mr. Pogson is one of Nature's gifted observers, and now holds the honorable place of Government astronomer. His opinion American astronomers will highly esteem.

But Professor Smyth's own genial words in an accompanying private note are scarcely less complimentary and are amusingly to the point. Speaking of American progress in astronomy he says:—

"For even I can remember when American officers seemed to think, all the needs of ambition served, when they had obtained a London-made sextant and artificial horizon. But now the very directors of British observatories are sighing in vain and in despair for the new style of American instruments with their beautiful Quaker-like simplicity and rapid effectiveness for obtaining their point."

Meteors.

On the night of November 27, 1885, my mother, my brother Percival, and I saw two hundred and thirteen (213) meteors during the time from 6:30 p. m. to 7:50 p. m. Of this number my mother counted only about twenty, as she watched but a short time. Many of the meteors were much smaller than those usually seen. Some, however, were quite large and bright, and as they shot along left a little streak of light behind them. Most of the meteors appeared a little north-east of the zenith, in the region of the Milky-way. Their paths were from four to ten degrees in length, six or seven degrees being the usual length. In falling most slanted off towards the east. During the last of our watch they were not so numerous as at the first. [Good for young Hall.—ed.]

Georgetown, D. C., 1885, November 28. ANGELO HALL.

Occultations in the Hyades.

Sept. 28th 1885: Early in the evening cloudiness prevented observation of the immersion of Theta[1] and Theta[2], *Tauri* but later on the sky became clear and the emersion of each star was beautifully seen.
The occultation of B A C 1391 was observed, though the brightness of the *Moon's* limb rendered doubtful the instant of disappearance.

Next in order came Alpha *Tauri*, whose immersion was observed with power of 165 on 4 1–10-inch refractor: For the other observations a power of 35 was used.

The times given in the Nautical Almanac for most phenomena suit us approximately, as we are so near, though occultations show very clearly the difference, both of latitude and longitude. Quite a neat illustration of this was noted on the present occasion.

The time given for the immersion of B A C 1391 was the same as that for the emersion of Theta[1], but as the time drew near, it became evident that both would not occur at the same moment. The star Theta[1] *Tauri* flashed out on the dark sky, while B A C 1391 was yet 40″ from the *Moon's* limb. The times given below are 75° time:

	Immersion	Emersion
Theta[2] *Tauri*	not seen	10*h* 45*m* 45*s*
Theta[1] "	" "	10 54 0
B A C 1391	10*h* 55*m* 20*s*	not seen
Alpha *Tauri*	13 14 20	14 58 50

Meteors of November 26–29 1885.

The shower of meteors (evidently the debris of Biela's comet) was well observed at Cambridgeport.

The first indication of the display was observed on the evening of the 26 (22, 23, 24, 25 being overcast) as during a partially clear interval, from 7*h* to 8*h*, forty-two meteors were recorded, thirty-seven being from the Biela radiant point.

The evening of the 27 was very clear, and a watch of two hours from 6*h* to 7*h*, and from 7:15*h* to 8:15*h*, revealed two hundred and sixty-one meteors of which number two hundred and fifty were Biela's. The radiant point was very accurately determined from several very short paths near the center of radiation to be at R. A. 22½°;+42½° between Chi and *u Andromadæ*. Traces of the shower were also noted on the 28 and 29.

Cambridgeport, Mass. EDWIN F. SAWYER.

Minor planet (252) was discovered in Nice by Perotin. R. A. 1*h* 8*m* 53.2*s*; Decl. +7° 8′ 19″ on October 27.2999, Gr. M. T.

The Biela Meteors.

In a short watch at Bloomington on the evening of November 26, I counted meteors of the Biela group at the rate of sixty per hour, and at one time I saw five in three minutes. The night of the 27th was cloudy

Bloomington, Indiana, 1885, Nov. 28. DANIEL KIRKWOOD.

Georgetown, D. C., November 27, 1885.

This evening at seven o'clock, having incidentally seen a few meteors shoot from the northern sky, I thought it worth while to count them, and perhaps determine their radiant point. With the assistance of G. Haneman, J. Dentz, W. Lee and T. Horigan, stationed in different position s we began to count at the time above stated with the following results:

No. from	7*h*		to 7*h* 30*m*		100
"	" 7	30*m*	to 7	55	100
"	" 7	55	to 8	38	100
"	" 8	38	to 9		28
			Total		328

The radiant point was as near as I could fix it,a 2nd magnitude star in foot of *Andromeda*. Some were quite bright, of about the 3rd magnitude, leaving short trains, color mostly white, and violet, the greater number were faint, and some scarcely visible. At 9 o'clock it became hazy and then clouded over. D. HORIGAN.

Communicated by Prof. Hall.

"A Star Shower."

In the evening of November 27 for about three hours we witnessed an unusual "star shower." The meteors were seen in all parts of the sky. A single observer could count from two to six per minute, and if the whole sky had been watched, from fifteen to forty could have been seen every minute. One observer saw three at the same instant.

The radiant point was in, or near, *Andromeda*, and as that constellation was in the zenith at that time, the paths of the meteors were mostly perpendicular to the horizon, though occasionally, one was seen to move nearly parallel to it.

The majority of them were small and yellow, but some were large, reddish and very brilliant and left a luminous train. Some of these trains were ten, and some were even thirty degrees in length, and were visible some seconds.

It is probable that the shower continued through the night and through the next day, for on the evening of the 28th, a few meteors were seen to come from the same radiant point. E. M. BARDWELL.

South Hadley, Mass., December 1st, 1885.

Minor planet (251) was discovered by Palisa, of Vienna, October 4.453 Gr. M. T., its place was R. A. 0*h* 0*m* 20*s*; Decl. −7° 5′.

Double Star B. A. C. 6814.

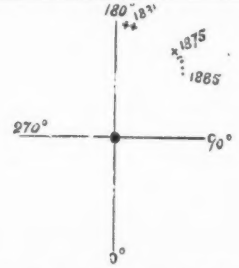
The double-star h 2904 (B. A. C. 6814) promises to be an interesting binary. The position of the star for 1885.0 is

R. A. $= 19^h\ 47.4^m$;

Decl. $= -24°\ 13'$.

The components are of the 6th and 10th magnitudes. The first measures were made by Sir John Herschel in 1831 when the position angle was 173°.5 and the distance 20″. ±. In 1875 Burnham found that the position angle had changed nearly 30°. Later measures show that the change is becoming more rapid both in angle and distance and is due to orbital motion. The following are all the measures I have been able to find:

Date	Position Angle	Distance	No. of nights	Observer
1831.	173.°5	20 ″ ±	1	Herschel
1834.6	170. 6	20 ±	1	Herschel
1875.1	144. 7	.....	1	Burnham
1877.73	141. 4	18. 30	2	Stone and Howe
1878.71	140. 8	18. 39	1	Burnham
1879.48	138. 9	18. 04	1	Egbert
1882.62	135. 8	17. 26	2	Wilson
1885.63	133. 0	16. 29	1	Wilson



The accompanying diagram shows graphically the change which has taken place since 1831. The approximate distances for the first three dates are indicated by crosses. H. C. WILSON.

Brilliant Meteor.

On the evening of Saturday, October 31, a very brilliant meteor was observed near Newark, Delaware. It dazzled the eyes of those who saw it, and lighted up the sky for several seconds like a grent flash of lightning. Information at hand is not more definite. F. G. U.

Baltimore.

Large Nebula in Field with General Catalogue 4510.

In Sidereal Messenger for October, 1884 (No 28) p. 254, I called attention to a new nebula that I had discovered; the place given being

$$\left.\begin{array}{l}\text{R. A.}=19^h\ 38^m\ 25^s \\ \text{Decl.}=-15^\circ\ 2'\ 50''\end{array}\right\} 1884.0$$

This object is in a lower power field with (and a little south, and a little *f*.) the small bright planetary nebula G. C. 4510. When I first saw this nebula on the night of August 17, 1884, it was very faint, and when some time later I determined its place with the 6-inch equatorial it was seen with difficulty. Since then I have frequently seen it, and it appears larger and brighter. I have on several occasions while not thinking of it swept it up and have been astonished at its distinctness.

I have lately examined it with the 6-inch and comet eye-piece, and find it fairly conspicuous, it certainly seems to be much larger and much denser than last year and I certainly think it has increased in density and size since that time.

This object is worthy of attention and I trust it may be examined by some one else. If it has always been as large and bright as now, I can not conceive how it could have been missed by observers when examining 4510 (G. C.). I have seen the small planetary nebula many times previously and swept over the region in search of comets, and cannot see why I failed to see the large nebula before August 17, 1884, unless it was fainter then With 6-inch this nebula is large and round and rather dense and even in its light. It is probably about 10′ or 15′ in diameter. There are several small stars involved in the preceding edge. Probably this is a variable nebula.

E. E. BARNARD.

Meteors November 27.

I sent a hurried notice to "*Science*" of the meteoric shower observed here on the evening of November 27. Since then I notice reports from Prof. Young of Princeton, the Messrs. Hall and others, who fix the radiant point near Gamma *Andromadæ*. I located the same in *Perseus*, a few degrees north and west of Gamma *Andromadæ*, but cannot persist that I located it very sharply, for strange to say, no meteor appeared within fifteen to twenty degrees of this point. I began my observation at 6:15 which seems to be as early as any reported, and this was probably the maximum of the shower. I counted 134 meteors from 6:15 to 6:45. The total number must have been much greater, as very many undoubtedly escaped my notice, sometimes three and four being visible simultaneously in different parts of the sky.

None reached the brightness of first magnitude stars, few reached the second, the greater number being faint, and many at the verge of visibility. They all left trains and they moved with medium speed.

ROBERT D. SCHIMPFF.

Scranton, Pa.

An item which has appeared in *Science*, *Nature*, and various papers and periodicals, stating that Beloit College Observatory has been closed for lack of funds is entirely without foundation.

Immediately upon the resignation of Mr. JOHN TATLOCK the present director was appointed and regular work was resumed in August.

Especial attention is given to sun-spot and spectroscopic work: a complete meteorological department has been added to the equipment and daily reports are published.

The college course has been extended for the philosophical division and students have regular work in different lines assigned to them.

A number of minor improvements in instruments have been made and the outlook is encouraging for further additions. CHAS. A. BACON.

BELOIT, WIS., November 19, 1885.

The follwing orders and subscriptions have not been previously acknowledged:

George H. Peters, Chicago, Ill. Miss R. J. Thompson, Franklin, Johnson Co., Ind. Rev. Edward Brown, De Schmet, Dakota. D. A, Robinson, "Herald Office," Boston, Mass. William Higginson, Vankleek Hill, Ontario, Canada. Henry A. Pavey, Hillsborough, Ohio. William Dawson, Spiceland, Indiana. L. L. Gregg, No. 122 Front St., N. Y. City (Vols. 4 and 5). Library Company of Philadelphia, N. W. corner of Juniper and Locust Sts., Philadelphia, Pa. (Vols. 2, 3 and 4). Professor G. F. Chambers, Sussex, England (Vols. 2, 3 and 4). Professor C. H. Stewart, Warrensburg, Mo. (Vols. 2, 3 and 4). Robert Elliott, Hannibal, Mo. J. T. Clark, Topeka, Kansas. Oliver Gibbs, Jr., Lake City, Minn. C. Q. Newcombe, Great Bend, Barton Co., Kansas. Professor W. A. Crusinberg, Lenox College, Hopkinton, Iowa. Professor H. L. Smith Hobart College, Geneva, N. Y. C. M. Charroppin, S. J. St. Louis University, St. Louis, Mo. E. S. Hall, Hoopeston, Ills. Henry A. Pavey, Hillsboro, Ohio (Vol. 5). Mrs. W. R. Stiles, Warren, Ohio. Kaiserl Uniniversitats, Sternwarte, Kassau, Russia. Henry A. Pavey, Hillsboro, Ohio (Vols. 2 and 3). W. E. Morgan, Spiceland, Ind. Charles G. Bœrner, Vevay, Indiana. Washington and Jefferson College Library, Washington, Pa. E. M. Bardwell, Mt. Holyoke Seminary, South Hadley, Mass. C. H. F. Peters, Litchfield Observatory, Clinton, N. Y. R. Rother, 238 Randolph, Detroit, Mich. C. L. Clippenger, Fort Wayne, Indiana. Professor M. S. Snow, Washington University, St. Louis, Mo. Professor Frank H. Begelow, Racine College, Racine, Wis. President Wm. H. Baxton, National Bank, Cambridge, Maryland. W. H. Numsen, 18 Light St., Baltimore, Md. Professor Daniel Kirkwood, State University, Bloomington, Indiana. Professor H. S. Freeman, Adelbert College, Cleveland, Ohio. J. Hagan, S. J. College of the Sacred Heart, Prairie du Chien, Wisconsin.

XUM

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1. Change of Season and Causes.
2. Tropics and Signification.
3. Zones and Origin.
4. Phenomenon of Midnight Sun.
5. Phazes of Moon.
6. Twilight Belt.
7. Tides and Eclipses.

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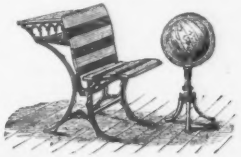

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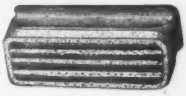

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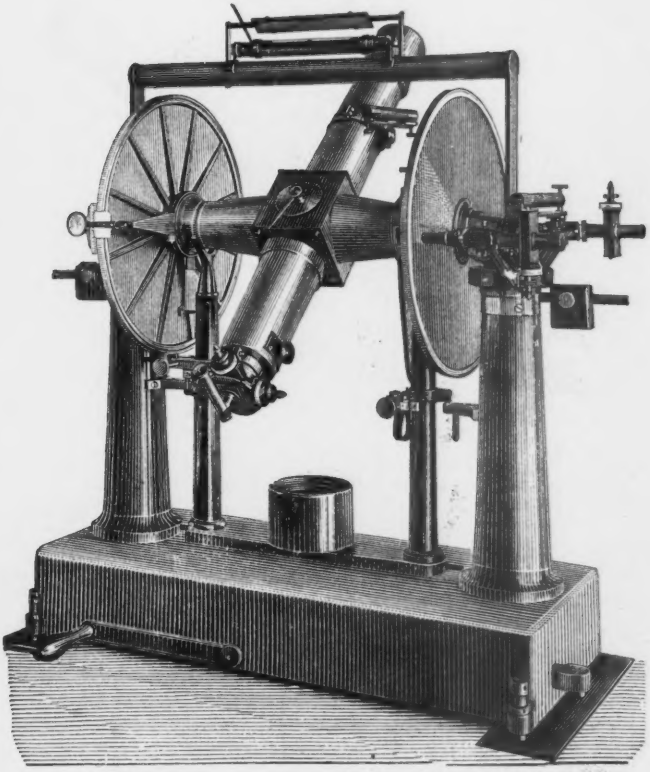

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